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Author(s): Bryant, Eleanor J., Kiezebrink, K., King, Neil A. and Blundell, John E.

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ORIGINAL  
RESEARCH  
PAPER

## Interaction between disinhibition and restraint: Implications for body weight and eating disturbance

E.J. Bryant<sup>1</sup>, K. Kiezebrink<sup>2</sup>, N.A. King<sup>3</sup>, and J.E. Blundell<sup>4</sup><sup>1</sup>Centre for Psychology Studies, University of Bradford, UK, <sup>2</sup>Section of Nutrition and Health, University of Abertay, Dundee, Scotland, <sup>3</sup>Institute of Health and Biomedical Innovation, Human Movement Studies, Queensland University of Technology, Brisbane, Australia, and <sup>4</sup>Institute of Psychological Sciences, Faculty of Medicine and Health, University of Leeds, UK

**ABSTRACT.** An increase in obesity is usually accompanied by an increase in eating disturbances. Susceptibility to these states may arise from different combinations of underlying traits: Three Factor Eating Questionnaire (TFEQ) Restraint and Disinhibition. Two studies were conducted to examine the interaction between these traits; one on-line study (n=351) and one laboratory-based study (n=120). Participants completed a battery of questionnaires and provided self-report measures of body weight and physical activity. A combination of high Disinhibition and high Restraint was associated with a problematic eating behaviour profile (EAT-26), and a higher rate of smoking and alcohol consumption. A combination of high Disinhibition and low Restraint was associated with a higher susceptibility to weight gain and a higher sedentary behaviour. These data show that different combinations of Disinhibition and Restraint are associated with distinct weight and behaviour outcomes.

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## INTRODUCTION

The increased risk of weight gain in the current obesogenic environment threatens both physical and psychological health (1). Since obesity is not an inevitability, it is clear that in the same obesogenic environment, some individuals are more susceptible to gain weight than others. Susceptibility implies the presence of particular dispositions which promote a positive energy balance. Here susceptibility applies to behaviour (as opposed to metabolism), and it reflects a tendency to increase energy intake (eating) or to reduce energy expenditure (physical activity), which in turn, favours weight gain.

There is also potential conflict between the obesogenic environment which promotes weight gain and the societal demand to be lean - especially for females. In turn this could increase the susceptibility of some individuals to develop disturbed eating behaviour. Such individuals may possess a vulnerability to develop pathological eating disorders. Evidence suggests that the incidence of eating disorders is increasing (2, 3) which is mainly due to the

increase in bulimia nervosa (4). To gain a deeper understanding of characteristics associated with the susceptibility to weight gain and disordered eating behaviours, identification of early markers and personal dispositions associated with vulnerabilities would be useful.

Two eating behaviour traits which have emerged as important dispositions in identifying susceptibility to weight gain and susceptibility to disturbed eating behaviours are Restraint and Disinhibition, measured by the Three Factor Eating Questionnaire [TFEQ (5)]. Disinhibition refers to opportunistic eating behaviours and a readiness to eat (6), whereas Restraint refers to efforts at limiting food intake to control body weight and is considered a valid measure of intention to diet (7). Previous research has demonstrated that combining different scores from the Disinhibition and Restraint scales elicits distinct weight and behaviour outcomes. For example, individuals who score high on Disinhibition and low on Restraint (HDLR) show a higher body weight and BMI, whereas those who score low on Disinhibition and high on Restraint (LDHR) show a much lower body weight (8-

## Key words:

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## Correspondence to:

Eleanor Bryant, Centre for Psychology Studies, School of Social and International Studies, Richmond House, Bradford University, West Yorkshire, BD7 1DP, UK.

E-mail: e.j.bryant@bradford.ac.uk

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10). Furthermore, in response to consumption of preloads (11-13), stress (14) and negative affect (15), HDHR individuals respond by overeating. LDHR individuals however, maintain cognitive control over eating, and do not respond by over-consuming. This group is also able to resist hyperphagia in response to an increased palatability of food (16).

These data provide evidence that Disinhibition and Restraint can determine a normal or abnormal response to food. Furthermore, there is also evidence from eating disordered patients (anorexia nervosa, bulimia nervosa and EDNOS) to suggest that very high levels of Restraint are associated with severity of eating pathology (17-20). Although a very high Restraint score (approx. 19-20 on the TFEQ) typifies all anorexic patients, the restrictor sub-type has a lower than normal Disinhibition score and the binge-purge subtype a significantly higher Disinhibition score (17). This high Restraint/high Disinhibition combination reflects the periodic tendency to overeat in binge-purge anorexic (and bulimic) patients. It follows that high Disinhibition (particularly when coupled with high Restraint) could be used as a predictor to identify those at risk of eating disorders, particularly since Disinhibition and Restraint have been shown to increase over time in women, in line with their disturbed eating symptomatology (21).

It is clear that different combinations of Disinhibition and Restraint are associated with a susceptibility or resistance to uncontrolled overconsumption. However, whether these combinations of scores actually exert an effect on those behaviours which affect weight regulation (e.g. physical activity levels) in women needs to be assessed. It is therefore important to determine whether, in non-clinical individuals, Disinhibition and Restraint can indeed be used to identify those more at risk of disordered and dysregulated eating behaviours. To achieve these aims, two studies were carried out: one online study and one controlled laboratory-based study. These studies assessed the relative contributions of Disinhibition and Restraint to body weight, physical activity levels, health related behaviours (smoking and alcohol consumption), self-esteem and propensity towards disturbed eating behaviours in women.

## METHOD - STUDY 1

This was a large scale, web-based exploratory scoping exercise which took approximately twenty minutes for each participant to com-

plete. The study was announced as a survey of health and fitness, and was advertised around the university and the local community.

### *Participants*

There were a total of 739 hits on the site however, approximately 22% provided incomplete information, so their data were excluded from analysis. 426 participants fully completed the online study. Of the 426 participants who provided personal details, 75 were male and 351 female however, only females were included in the analysis. This was due to evidence suggesting that levels of TFEQ factors differ between males and females (22-24). In addition, females are known to have a higher susceptibility to disturbed eating behavior compared to males (25). Therefore it was deemed inappropriate to combine the male and female participants' data in the analysis. Participants were informed that they would receive feedback from the questions answered after the survey had been completed. The study received ethical approval from the Institute of Psychological Sciences Ethical Review Board.

### *Health and physical activity information*

Participants were asked to provide height and weight measures for the calculation of body mass index (BMI). Questions about current dieting status, smoking status and alcohol consumption were also requested. For the assessment of alcohol consumption, details regarding the number of units (strength of alcoholic drink: 1 unit = 10 ml or 8 g of pure alcohol) contained in standard measures of common UK alcoholic beverages were provided. Also, participants were asked about their physical activity (PA) levels, using the Allied Dunbar Fitness Survey six-point physical activity scale (26), which incorporates three elements of duration, frequency and intensity. Participants indicated on a scale (0 to 5) how much physical activity (of 20 minute duration) they had engaged in over the past four weeks. The levels indicate the following levels of physical activity are undertaken; at Level 0, no physical activity; Level 1, one to four occasions of moderate to vigorous activity; Level 2, five to eleven occasions of moderate to vigorous activity; Level 3, twelve or more occasions of moderate activity; Level 4, twelve or more occasions of moderate to vigorous activity; and Level 5, twelve or more occasions of vigorous activity. In addition, participants were asked to estimate the time they spent sitting per day. This was modified from the International Physical Activity Questionnaire (27) to determine participants' time spent sedentary.

### *The TFEQ*

The TFEQ was administered to assess levels of trait Disinhibition, Restraint and Hunger within the sample. The TFEQ is a 51-item questionnaire separated into two parts, the first 36-items involve a true/false response format, while the remaining 15-items use a 4-point Likert scale response format.

### *Procedure*

A pilot study was conducted to ensure the clarity of the questions and to screen for ambiguous or confusing questions before the questionnaire was launched online. Participants were recruited from posters placed around the University of Leeds, and from sending recruitment e-mails around the University of Leeds, with an attached web link to the study.

### *Data Analysis*

The sample was divided into four groups according to scores on the TFEQ factors – Disinhibition and Restraint: Low Disinhibition, Low Restraint (LDLR); Low Disinhibition, High Restraint (LDHR); High Disinhibition, Low Restraint (HDLR); and High Disinhibition, High Restraint (HDHR), using a median split of scores on the Disinhibition and Restraint scales to determine differences between particular combinations (LD=0-7; HD=8-16; LR=0-8; HR=9-21). These ranges are consistent with those used by Tepper and Ullrich (28) and Goldstein, Daun and Tepper (29).

Correlational analyses were carried out to determine the relationship between Disinhibition and Restraint with key variables. One-way ANOVAs were conducted to determine differences between the four groups on any given variable, and Bonferroni post hoc comparisons were employed to determine where the differences existed. Where parametric or homogeneity assumptions were violated, the nonparametric Kruskal-Wallis test was carried out, followed by Mann-Whitney U tests for post hoc comparison.

## **RESULTS - STUDY 1**

By definition and design, Disinhibition and Restraint scores differed between the four groups ( $F_{(3,347)}=246.65$ ,  $p<0.001$ ) and ( $F_{(3,347)}=296.61$ ,  $p<0.001$ ) respectively (see Table 1). Scores on the Hunger factor also differed significantly between groups ( $F_{(3,347)}=33.22$ ,  $p<0.001$ ). A post hoc analysis revealed that both groups with a high Disinhibition score, although not different from one another, showed significantly higher

Hunger scores compared to the low Disinhibition groups ( $p<0.01$ ).

The mean BMI of the groups are presented in Table 1. There was a significant difference in BMI between the groups ( $F_{(3,328)}=6.97$ ,  $p<0.01$ ). The post hoc analysis demonstrated that the HDLR had the highest BMI, while the LDLR group had the lowest BMI ( $p<0.01$ ) (see Table 1). Thus those women with a higher Disinhibition score exhibited a higher BMI, and the expression of this was moderated by Restraint. Age did not differ significantly between groups ( $F_{(3,349)}=1.96$ , n.s.). BMI was significantly and positively correlated with Disinhibition ( $r=0.23$ ,  $df=330$ ,  $p<0.01$ ), although the association is relatively weak. BMI did not significantly correlate with Restraint ( $r=0.07$ ,  $df=330$ , n.s.).

### *Health Related Behaviours*

#### Smoking behavior

Although 67% of the sample reported having never smoked, of the 115 women who have smoked, or currently smoke, 42.6% were in the HDHR group. When the sample was considered as a whole (including those who did not smoke), the HDHR group showed a higher likelihood of engaging in smoking behavior ( $\chi^2=16.27$ ,  $df=3$ ,  $p<0.01$ ). The post-hoc analysis revealed that the HDHR group were more likely to be smokers than the LDLR women ( $U=4228.50$ ,  $p<0.01$ ), the LDHR women ( $U=2727.00$ ,  $p<0.01$ ) and the HDLR women ( $U=2774.00$ ,  $p<0.05$ ).

#### Alcohol consumption

There was a significant difference in alcohol consumption between the groups ( $F_{(3,347)}=2.83$ ,  $p<0.05$ ). Post hoc analysis revealed that the HDHR group consumed significantly more units of alcohol per week compared to the LDHR group ( $p<0.05$ ). Disinhibition correlated positively and significantly with alcohol consumption ( $r=0.16$ ,  $df=349$ ,  $p<0.01$ ), whereas Restraint did not ( $r=0.05$ ,  $df=349$ , n.s.).

#### Dieting Status

Participants were asked to indicate if they were currently dieting or not. A Kruskal-Wallis analysis revealed a significant difference between the groups on dieting status ( $\chi^2=49.42$ ,  $df=3$ ,  $p<0.01$ ), where significantly more HDHR women were currently dieting compared with the HDLR group ( $U=2239.00$ ,  $p<0.01$ ), the LDHR group ( $U=2913$ ,  $p<0.01$ ) and the LDLR group ( $U=3627.5$ ,  $p<0.01$ ). Also there were significantly more women on a diet in the LDHR group compared with the LDLR group ( $U=3527$ ,



$p < 0.01$ ). Therefore, a higher Restraint score is reflective of a higher likelihood of being on a diet, which is exacerbated by a concurrent high Disinhibition score.

### *Level of Physical Activity*

#### General Physical Activity

Participants were asked to rate their physical activity (PA) level on a scale of 0 to 5, depending upon the amount and intensity they had carried out over the last 4-weeks (26). A minority (7.7%) of women did not answer this question. A significant difference between groups was evident ( $F_{(3,312)} = 3.89$ ,  $p < 0.01$ ). The LDLR group reported a higher level of PA compared with all groups (see Table 1 for PA profiles).

### *Estimated sedentary behaviour*

There was a positive correlation between estimated sitting hours per day and Disinhibition ( $r = 0.16$ ,  $df = 337$ ,  $p < 0.01$ ), but no association with Restraint ( $r = -0.03$ ,  $df = 337$ , n.s.).

## SUMMARY OF STUDY 1

The online study highlighted how women with different combinations of Disinhibition and Restraint show distinct behaviour patterns. For instance, the HDLR women had a higher BMI and a higher reported level of sedentary behaviour. On the other hand, the HDHR women reported greater smoking and

alcohol consumption and a higher likelihood of dieting. These data suggest that Disinhibition and Restraint play a role in the expression of different characteristics which influence body weight regulation and health related behaviours. Due to the behaviour patterns between HDHR and HDLR women being quite distinct, an investigation of whether Disinhibition and Restraint influenced personality characteristics known to be associated with eating behaviour and eating disturbance was conducted.

## METHOD - STUDY 2 - LABORATORY BASED

### *Participants*

This was a large questionnaire based study, in which women attended the Human Appetite Research Unit, University of Leeds. 120 female participants were recruited from the staff and students of the University of Leeds, aged between 19 and 48 years. Only a small proportion of participants in study 1 (15%) had a BMI above 25 (mean  $30.09 \pm 2.32$  kg/m<sup>2</sup>), therefore, in order to prevent the level of overweight from unduly influencing the outcome, recruitment was restricted to women with a BMI between 20-25 kg/m<sup>2</sup>. Participants were initially screened for suitability using a telephone interview to confirm their gender, normal weight status and absence of an eating disorder.

**TABLE 1**  
Mean ( $\pm$ SD) TFEQ, age, BMI, health behaviours, and physical activity (PA) measures (study 1).

N	LDLR 109		LDHR 74		HDLR 68		HDHR 100	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Restraint	4.19	2.18	12.64*** <sup>1</sup>	2.90	4.97	2.25	12.73*** <sup>2</sup>	2.92
Disinhibition	3.94	2.09	4.77	2.10	10.07*** <sup>3</sup>	2.00	10.78*** <sup>4</sup>	2.36
Hunger	4.25	2.63	4.00	3.08	7.79** <sup>5</sup>	3.39	7.11** <sup>6</sup>	3.28
Age (years)	27.76	10.67	29.58	11.60	26.74	11.25	25.70	9.94
BMI (kg/m <sup>2</sup> )	22.07* <sup>7</sup>	3.57	22.49	3.30	24.26* <sup>8</sup>	4.17	23.94	3.84
Smoking (%)	25.2%		15.7%		16.5%		42.6%** <sup>9</sup>	
Alcohol Consumption (units/week)	9.39	8.50	7.91	6.37	9.76	9.56	11.70* <sup>10</sup>	9.89
Dieting (%)	3.70%		16.20%		2.90%		35.10%** <sup>11</sup>	
PA level†	3.70** <sup>12</sup>	1.27	3.06	1.34	3.58	1.18	3.58	1.26
Estimated sitting (hr/d)	7.58	2.98	7.69	2.88	8.61	2.90	7.96	2.42

<sup>1</sup>&<sup>2</sup>\*\*\* $p < 0.001$  –HDLR and HDHR groups significantly higher Disinhibition scores compared to LDLR and LDHR groups, <sup>3</sup>&<sup>4</sup>\*\*\* $p < 0.001$  –LDHR and HDHR groups significantly higher Restraint score compared to LDLR and HDLR groups, <sup>5</sup>&<sup>6</sup>\*\* $p < 0.01$  –HDLR and HDHR groups significantly higher Hunger scores compared to LDLR and LDHR groups, <sup>7</sup>\*\* $p < 0.01$  –LDLR group significantly lower BMI compared to HDLR and HDHR groups, <sup>8</sup>\* $p < 0.05$  –LDHR group significantly lower BMI compared to HDLR group, <sup>9</sup>\*\* $p < 0.01$  –HDHR report higher smoking rate than other groups, <sup>10</sup>\* $p < 0.05$  –HDHR group reported higher alcohol consumption, <sup>11</sup>\*\* $p < 0.01$  –HDHR group higher dieting frequency compared to all other groups, <sup>12</sup>\*\* $p < 0.01$  –LDLR significantly higher PA level compared to LDHR group. †PA level is a score ranging from 0-5 and is derived from the Allied Dunbar Fitness Survey (1992).

**TABLE 2**  
Mean ( $\pm$ SD) TFEQ, age, BMI, personality characteristics and eating disturbance measures (study 2).

N	LDLR 62		LDHR 16		HDLR 24		HDHR 15	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Restraint	3.00	2.02	12.25**** <sup>1</sup>	2.35	3.41	2.47	12.13**** <sup>2</sup>	2.50
Disinhibition	3.90	2.05	4.50	1.71	10.21**** <sup>3</sup>	1.98	9.94**** <sup>4</sup>	1.81
Hunger	4.24	2.08	4.25	2.54	8.96** <sup>5</sup>	2.99	7.06** <sup>6</sup>	3.09
Age (years)	25.85	6.23	29.00* <sup>7</sup>	9.56	23.08	3.06	25.13	5.94
BMI (kg/m <sup>2</sup> )	21.58	1.92	22.54	1.77	21.82	2.32	22.40	2.12
Extraversion (EPI)	15.79	4.26	14.50	4.77	16.33	3.10	13.50	4.34
Neuroticism (EPI)	10.89** <sup>8</sup>	4.73	11.31** <sup>9</sup>	4.38	15.54**** <sup>10</sup>	3.89	15.06	2.79
Self-Esteem (RSES)	19.02	3.93	21.00	4.76	21.46	5.05	23.25** <sup>11</sup>	3.73
EAT-26	2.02* <sup>12</sup>	1.75	4.13	3.76	2.54	2.38	6.63**** <sup>13</sup>	4.87

<sup>1</sup>2\*\*\*\*p<0.0001 –LDHR and HDHR groups significantly higher Restraint scores compared to HDLR and LDLR groups, <sup>3</sup>84\*\*\*\*p<0.0001 –HDLR and HDHR groups significantly higher Disinhibition scores compared to LDLR and LDHR groups, <sup>5</sup>86\*\*p<0.01 –HDLR and HDHR groups significantly higher Hunger scores compared to LDLR and LDHR groups, <sup>7</sup>\*\*p<0.05 –LDHR group significantly older than HDLR group, <sup>8</sup>\*\*p<0.01 –LDLR group significantly lower Neuroticism score compared to HDHR group, <sup>9</sup>\*\*p<0.01 –LDHR group significantly lower Neuroticism score compared to HDLR group, <sup>10</sup>\*\*\*\*p<0.0001 –HDLR group significantly higher Neuroticism score than LDLR group, <sup>11</sup>\*\*p<0.01 –HDHR significantly higher RSES score (therefore lower self-esteem) than LDLR group, <sup>12</sup>\*p<0.05 –LDLR group significantly lower EAT-26 score compared to LDHR group, <sup>13</sup>\*\*\*\*p<0.0001 –HDHR group significantly higher EAT-26 score compared to LDLR and HDLR groups.

#### Anthropometric data

Height was measured in centimetres using a Leicester stadiometer, and measurement was recorded to the nearest centimetre. Weight was measured in kilograms using a digital scale (MSP 200, SECA) calibrated to an accuracy of 0.10 kg.

#### Questionnaires

Participants completed four questionnaires to assess factors of personality and eating disturbance. Participants completed the TFEQ (5), Eysenck's Personality Inventory [EPI (30)], Rosenberg's Self-Esteem Scale [RSES (31)] and the Eating Attitudes Test-26 [EAT-26 (32, 33)]. The EPI measures two personality dimensions: Extroversion-Introversion and Neuroticism-Stability. It is a 57-item questionnaire with a yes/no response format. Extroversion and Neuroticism have been found to be related to disordered eating in normal and clinical populations (34). The RSES is a measure of global self-esteem, and is measured via 10 items. Responses are measured using a 4-point Likert Scale from 'strongly agree' to 'strongly disagree', producing scores from 10 to 40, where lower scores are indicative of greater self-esteem. Self-esteem has been found to be of importance in the aetiology of eating disorders (35), and the EAT-26 assesses the presence and severity of eating disorders, namely anorexia nervosa and bulimia nervosa. The EAT-26 is a 26-item scale utilising a 6-point response format ranging from 'always' to 'never'.

#### Procedure

After responding to recruitment advertisements displayed on the University of Leeds campus, participants were screened by a telephone interview and an appointment was made to visit the Human Appetite Research Unit. Here participants' heights and weights were measured and the battery of questionnaires completed.

#### Statistical Analysis

Similar to the on-line study the sample was divided into four groups on the basis of Disinhibition and Restraint scores (HDHR, HDLR, LDHR, LDLR) using criteria defined by a median split on the Disinhibition and Restraint scores from the population sample of the online study. These criteria were chosen for consistency, to make comparison between the two studies possible.

## RESULTS - STUDY 2

As intended by the design, Disinhibition and Restraint scores differed significantly between the groups ( $F_{(3,115)}=129.58$ ,  $p<0.0001$ ) and ( $F_{(3,115)}=84.99$ ,  $p<0.0001$ ) respectively (see Table 6). Hunger scores also differed significantly between the groups ( $F_{(3,115)}=18.54$ ,  $p<0.0001$ ), with both the high Disinhibition groups having significantly higher Hunger scores independent of Restraint score.

There were no significant differences in BMI between the groups ( $F_{(3,115)}=1.39$ , n.s.). However, BMI was found to correlate significantly with Restraint ( $r=0.21$ ,  $df=117$ ,  $p<0.01$ ), but not with Disinhibition ( $r=0.07$ ,  $df=117$ , n.s.). See Table 2 for descriptive data.

#### *Extraversion and Neuroticism*

The groups differed significantly on their Neuroticism scores ( $F_{(1,115)}=9.19$ ,  $p<0.0001$ ). The groups with high Disinhibition scores had a higher neuroticism score regardless of their Restraint score (see Table 2). There were no significant differences apparent between the groups in relation to their level of Extraversion ( $F_{(1,115)}=1.97$ , n.s.), although the groups with low Restraint tended to have a higher level of Extraversion. Disinhibition correlated positively with Neuroticism ( $r=0.49$ ,  $df=117$ ,  $p<0.0001$ ). There was a negative association between Restraint and Extraversion ( $r=-0.25$ ,  $df=117$ ,  $p<0.01$ ), however there was no significant association with Neuroticism ( $r=0.08$ ,  $df=117$ , n.s.).

#### *Self-Esteem (RSES)*

Self-esteem was found to differ significantly between the groups ( $F_{(1,115)}=5.19$ ,  $p<0.01$ ). The groups with the lowest (HDHR) and highest (LDLR) levels of self-esteem were significantly different ( $p<0.01$ ) (see Table 2). There was a significant positive correlation between both Disinhibition and Restraint and self-esteem score ( $r=0.36$ ,  $df=117$ ,  $p<0.001$ ;  $r=0.21$ ,  $df=117$ ,  $p<0.05$  respectively), indicating that high scores on Disinhibition and Restraint are associated with a lower self-esteem (high RSES signifies low SE).

#### *Likelihood of disturbed eating behaviour (EAT-26)*

The groups showed a differing propensity towards disturbed eating behaviour ( $F_{(1,115)}=12.82$ ,  $p<0.0001$ ). The HDHR exhibited the highest EAT-26 score, whereas the LDLR group had the lowest score. Even though the scores on the EAT-26 are relatively low in this sample, those women with a high Restraint score appear to have a higher propensity towards disturbed eating, particularly when they exhibit a concurrent high Disinhibition and high Restraint score. Disinhibition and Restraint were both correlated with EAT-26 scores ( $r=0.21$ ,  $df=117$ ,  $p<0.05$  and  $r=0.54$ ,  $df=117$ ,  $p<0.0001$  respectively).

## DISCUSSION

These studies have uncovered a number of important relationships amongst TFEQ scores,

personality characteristics and eating behaviour factors, which may contribute to understanding how the eating behaviour traits Disinhibition and Restraint are associated with body weight, eating behaviour and lifestyle choices.

The most striking finding from both studies is the identification of more problematic eating and health behavior characteristics in the HDHR group. Study 1 revealed that the HDHR group showed a higher BMI, a higher likelihood of smoking behavior, a higher alcohol consumption and a higher incidence of dieting. In addition, study 2 revealed that this group was also characterized by a higher propensity toward disturbed eating behavior (EAT-26), a high neuroticism and a lower self-esteem. Collectively, this portfolio of behavior characteristics could be debilitating for physical (higher smoking rates, alcohol consumption and dieting) and psychological health (reflected in the lower self-esteem and higher EAT-26 score).

Both studies demonstrated that in normal weight individuals a higher Restraint score coupled with a high level of Disinhibition reflects the relationship between opportunistic eating and restriction of food intake. This could be advantageous as the control over food intake (represented by Restraint) can moderate the effect of Disinhibition, thus maintaining a normal weight range (36). However, when Restraint and Disinhibition are simultaneously high (i.e., HDHR), the combination appears to be more damaging. On the one hand HDHR women are susceptible to the overeating and emotional eating tendencies of high Disinhibition, however, they are also influenced strongly by the desire to restrict food intake (Restraint). This conflict may result in a cyclical pattern of food restriction (and efforts to control food intake, such as dieting and smoking) and overeating, which could ultimately lead to a problem with weight control - reflected in the higher BMI of this group in study 1. This cyclical pattern of restriction and overeating is reflected well in studies which demonstrate a 'disinhibition effect'. Here participants overeat (thus cannot maintain restraint over eating) in a variety of situations, such as being exposed to stress (37), in the presence of palatable food (16) and following a preload (11, 38).

Issues with weight-control will inevitably lead to efforts to control weight such as an increased frequency of dieting, as found in study 1. However, the increased smoking behaviour of the HDHR women could also function as a weight control strategy. Copeland and Carney (39) and Pomerleau et al. (40) both found that women with high Disinhibition and high Restraint scores reported higher expecta-

tions of improved appetite and weight control from smoking than other groups.

The increased alcohol consumption reported by the HDHR group confirms previous reports (41-43). This behavior of increased alcohol consumption may seem counterintuitive as it would conflict with efforts to control body weight. However, evidence suggests that dieting frequency is positively associated with alcohol consumption (44) and that previous dieting behavior is predictive of future alcohol intake (45). It is unclear as to whether it is a high Restraint or a high Disinhibition which promotes a higher alcohol consumption, however Higgs and Eskenazi (43) propose that it is the combination of the tendency to restrict intake coupled with the tendency to disinhibit which leads to a higher alcohol intake, due partly to the greater preoccupation with thoughts of alcohol in this group. Higgs and Eskenazi however, used the Dutch Eating Behaviour Questionnaire [DEBQ (46)] to measure Restraint and the TFEQ to measure Disinhibition. Our results therefore suggest that use of the TFEQ to measure both Restraint and Disinhibition elicits similar results in terms of alcohol consumption.

The conflict between the high Restraint and high Disinhibition characteristics could ultimately lead HDHR women to be susceptible to disturbed eating behaviours (EAT-26), which could increase their vulnerability to disordered eating patterns (18). The evidence suggests that women with bulimia nervosa (BN) exhibit a concurrent high Disinhibition and high Restraint (17, 47), where this combination is associated with severity of disease pathology (48). Taken together, this evidence shows how in non-eating disordered and eating disordered individuals, the combination of high Disinhibition and high Restraint functions similarly in terms of problematic eating behaviour; a concurrent high score on Disinhibition and Restraint is clearly predictive of disturbed eating behaviour. However, it should be kept in mind that scores in the lower ranges of the EAT-26 do not indicate pathological behaviour. However, higher scores in these lower ranges may be a marker of a predisposition to develop abnormal eating. Indeed, lower cut-off points of the EAT-26 were recently suggested to indicate higher risk for eating disordered behavior in non-clinical samples (49).

It is important to note here that the individual association of both Disinhibition and Restraint with eating disturbance has been previously reported by Lawson et al. (20). However, contrary to Lawson et al., our data suggest that Disinhibition and Restraint interact to produce a heightened vulnerability to eating distur-

bance. The interaction between Disinhibition and Restraint appears to be potent, where the conflict between these two traits (between restriction and a tendency towards opportunistic eating) can lead to an increased vulnerability to eating disturbance. Therefore, the consideration of the interaction between Disinhibition and Restraint seems to be valuable in identifying a more problematic eating behavior profile.

A further striking feature of the HDHR group was the combination of high neuroticism, low extroversion and low self-esteem scores which supports existing evidence associating different personality variables to BMI and eating behavior (e.g. 50). This combination of personality traits has been associated with problematic eating behaviour. For example, Tylka (51) demonstrated that a higher neuroticism was associated with body image disturbance. In addition, Provencher et al. (50) demonstrated that for overweight and obese women a higher level of neuroticism was predictive of higher Disinhibition, Restraint and Hunger scores. In the present study, the association of high Disinhibition and high Restraint with a higher neuroticism and low extroversion is apparent in normal weight women and it is hypothesized that this combination of personality and eating behaviour traits can lead to an increased likelihood of disturbed eating behaviour which is reflected in the higher EAT-26 score of this group.

While the High Disinhibition, High Restraint combination appears predictive of problematic eating behaviours, the High Disinhibition, Low Restraint combination appears to be predictive of weight gain. The HDLR women appear to be characterized by a higher BMI and high sedentary behaviour, with HDLR women reporting more sitting hours per day and less leisure time physical activity. In the HDLR group, the opportunistic eating and readiness to eat tendencies of Disinhibition are not moderated by efforts to control body weight (Restraint), which promotes a higher BMI (8, 10, 52). It is important to note that in study 2, the HDLR group did not display the highest BMI, however this group was selected to be homogenous, young and normal weight.

The sedentary behaviour exhibited by HDLR women will likely result in a lower energy expenditure and promote a positive energy balance eventually leading to weight gain. It is known that there is an uncoupling between energy expenditure and energy intake (53, 54), where the low level of energy expenditure does not lead to a corresponding down regulation in energy intake. The classic study by Mayer, Roy and Mitra (55) demonstrated that appetite is poorly regulated at low activity levels. Thus a



habitually low physical activity level will constitute an additional factor favouring weak appetite control. This is supported by evidence which suggests that high Disinhibition individual's have both a greater tendency towards hyperphagia as well as a tendency towards a lower physical activity level (20).

These analyses of the TFEQ factors of Disinhibition and Restraint have indicated how different combinations are associated with different outcomes for general health and susceptibility to appetite dysregulation. The susceptibility of different groups to weight control problems and eating disturbances becomes apparent. The two studies carried out suggest that high Disinhibition coupled with high Restraint is problematic. These women are characterised by a higher vulnerability towards disturbed eating behaviours, a higher tendency to diet, smoke and consume alcohol; whereas those women who show a HDLR score, show an increased vulnerability towards a higher body weight and a higher tendency towards sedentary behaviour. These data highlight the important role of psycho-markers of eating behaviour in body weight regulation and the susceptibility to weight gain. The distinct behavioural outcomes due to the interaction between Disinhibition and Restraint suggest that scores on these two factors could be used as an early marker of susceptibility to disturbed eating behaviours.

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